LESOURD

Calibration of Weirs
in the
Hydraulic Laboratory
of the Univ. of Ill.

Civil Engineering
B. S.

1903

CALIBRATION OF WEIRS IN THE HYDRAULIC LABORATORY

OF THE

UNIVERSITY OF ILLINOIS

BY

ALFRED CURTIS LESOURD

THESIS

FOR

DEGREE OF BACHELOR OF SCIENCE

IN

CIVIL ENGINEERING

COLLEGE OF ENGINEERING

UNIVERSITY OF ILLINOIS

PRESENTED JUNE 1903

UNIVERSITY OF ILLINOIS

June 1, 1903

This is to certify that the thesis prepared under the supervision of Professor Talbot by ALFRED CURTIS LE SOURD, entitled CALIBRATION OF WEIRS IN THE HYDRAULIC LABORATORY OF THE UNIVERSITY OF ILLINOIS, is approved by me as fulfilling this part of the requirements for the Degree of Bachelor of Science in Civil Engineering.

Ira O. Baker.

Head of Department of Civil Engineering

Calibration of Weirs

The measurement of water by means of weirs is a very convenient and precise method, and is the one most generally used for measuring large quantities of water. The object of this thesis is to determine the coefficients of discharge for the two channel weirs in the Hydraulic Laboratory at this university. These weirs are used to measure water for experimental work in hydraulics; they are used to find the capacity of pumps; and in all cases where large quantities of water are to be measured, the measurement is made by these weirs. Since the coefficient of flow varies with the head of water flowing over the weir, with the length of the weir,

with the depth, width, and slope of the channel, with the thickness of the weir crest, and with the distribution of the velocity across the channel, it is essential, if these weirs are to be used for the accurate measurement of water, that experiments be made to determine these coefficients.

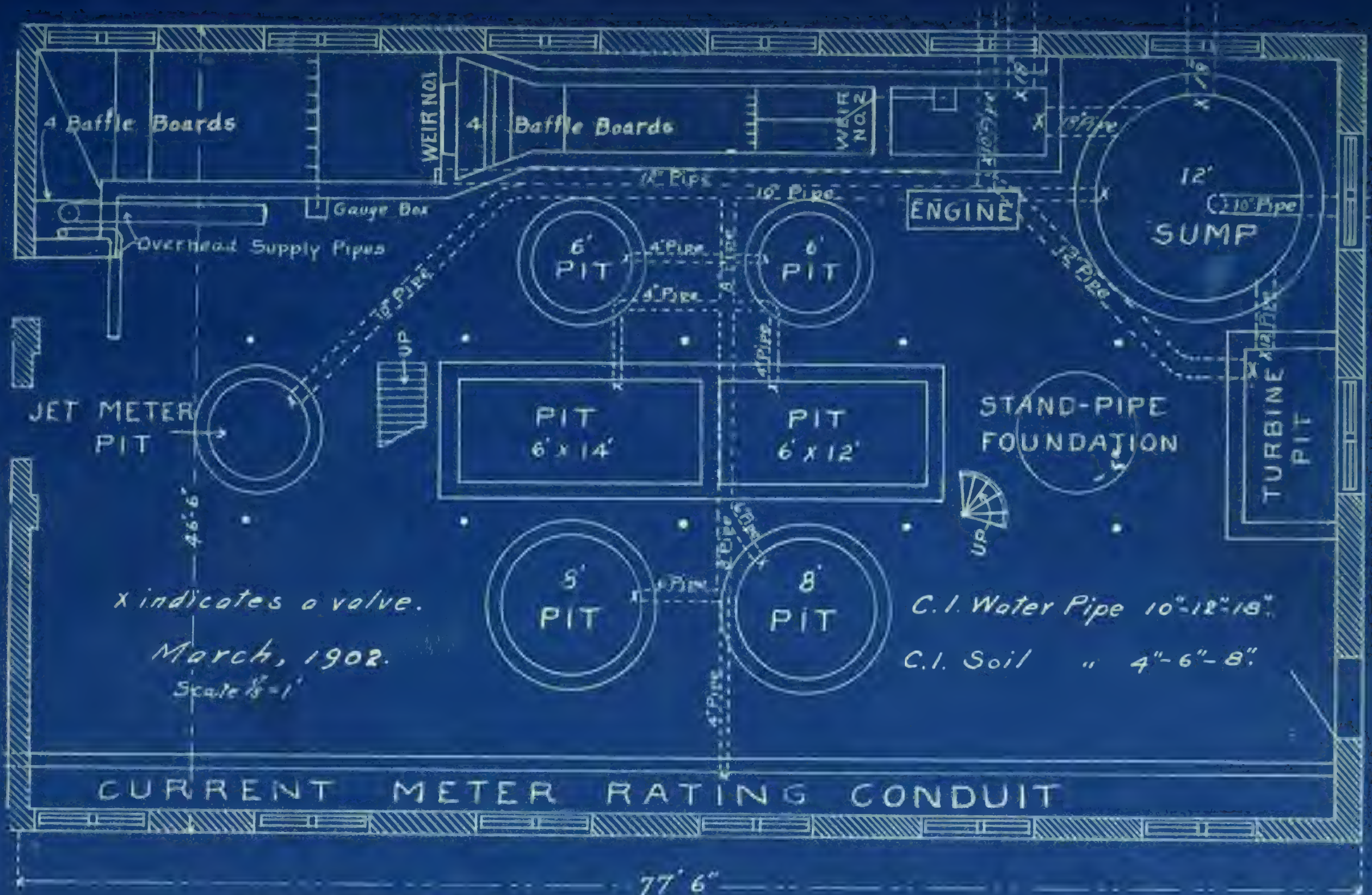
The calibration of the weirs consists in finding for each head of water flowing over the weir the value of the coefficient C in the well-known weir formula $Q = C\frac{2}{3}\sqrt{2g}\,L\,H^{\frac{3}{2}}$ in which Q = quantity of water discharged in cu. ft. per sec.; C = ratio of the actual to the theoretical discharge; L = length of weir in feet; and H = head of water in feet on the weir. The coefficients for the suppressed weir were first found by actually measuring the quantity of water flowing over the weir. Having these coef-

ficients, the coefficients for the contracted weir were not deter-mined, the quantity of water flowing over the weir being meas-ured by the suppressed weir.

The upper weir, which will be designated Weir No. 1, is 3 ft long and has end contractions. The weir channel is 24 ft. long and 7 ft. wide. The crest of the weir is 3 ft. above the bottom of the channel, and is formed by a steel plate 15/100 in. thick, which is bolted to the concrete partition wall. The lower weir is located 25 ft. below Weir No. 1; it is a weir with suppressed end contractions, and is 3 ft. long. This weir will be designated Weir No. 2. The crest of the weir is 27 in. above the bed of the channel, and is formed by a steel plate 15/50 in. thick, which is bolted to the concrete partition wall. A vacuum is prevented

from forming under the falling sheet of water by means of a 1½-in pipe with 5/16-in holes in the underside, which extends across the channel, then up alongside the channel wall where air may be secured.

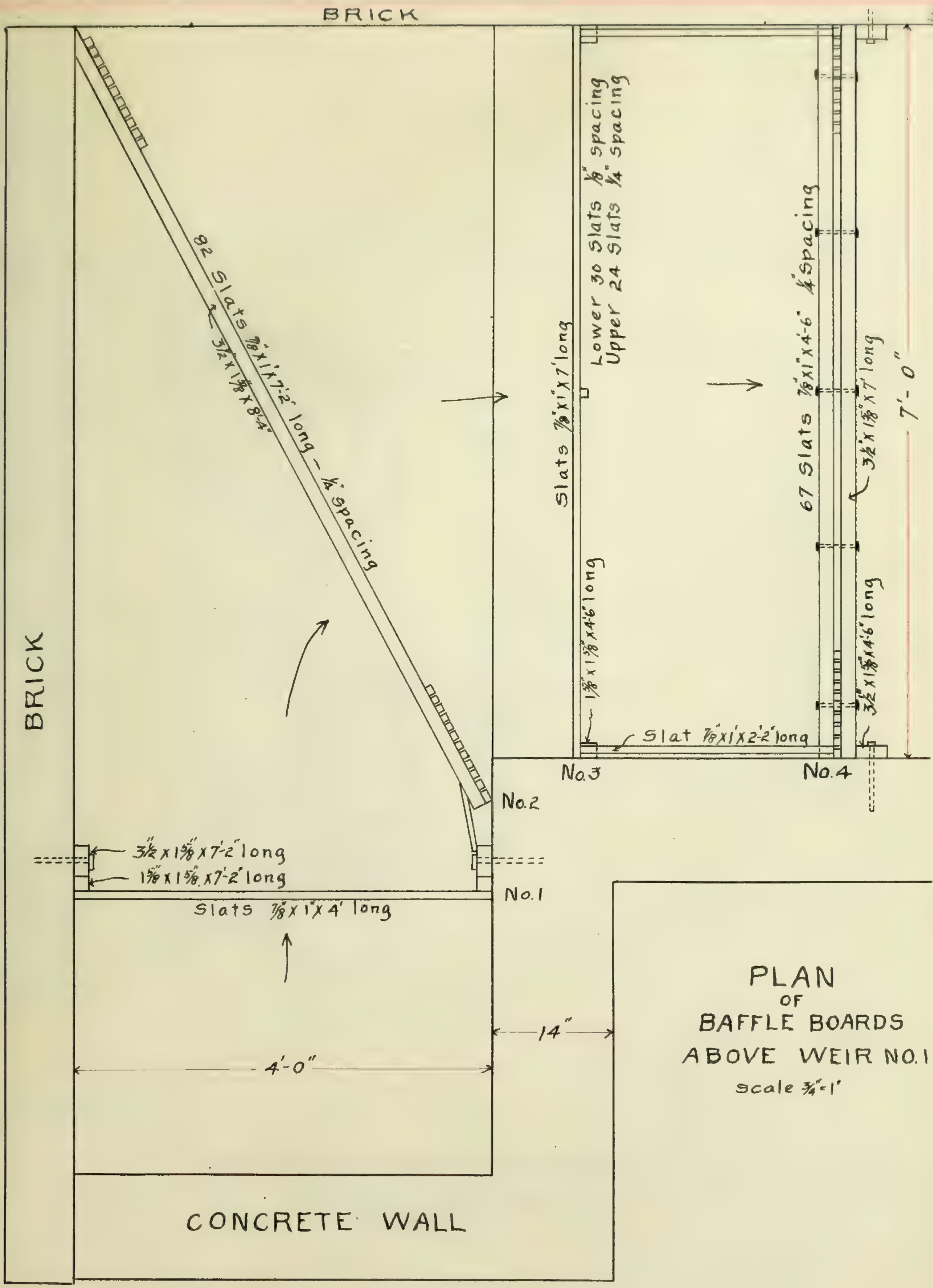
The location of weirs, standpipe, communicating pipes, sump, and pumps may be seen on accompanying plan of basement of hydraulic laboratory. Water may be obtained from the storage tanks in the University Water Works, from the standpipe, or from the sump through the pumps, by opening or closing valves in the 8-in, or 12-in. pipe, which supply water to the weirs. The two storage tanks are made of steel plate ¼-in. thick; they are 20 ft. in diameter and 13 ft. high. The standpipe rests on a foundation 9½ ft. above the basement



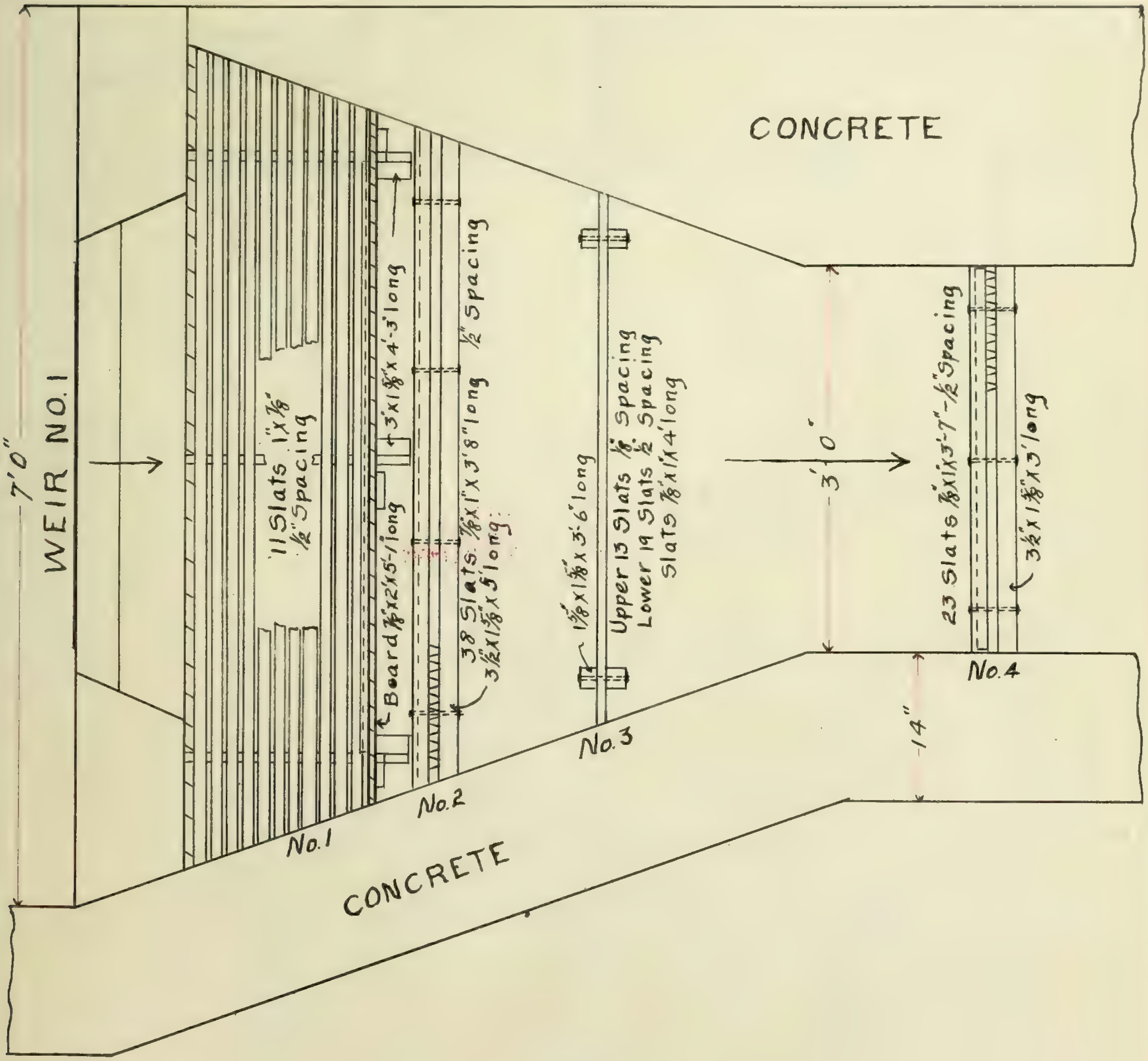
BASEMENT PLAN OF HYDRAULIC LABORATORY
SHOWING LOCATION OF UNDERGROUND PIPES AND VALVES

floor; it is 4 ft. in diameter and 60 ft high. The sump is about 12½ ft. in diameter, and is about 7½ ft deep below the floor line and 2½ ft. high above the floor line. The pumps are placed at the top of the sump and are supported by 4 6-in I beams imbedded in the concrete walls of the sump. The principal use of the steam pump is to pump water from the sump into the standpipe; while the centrifugal pump is used to supply large quantities of water for the basins.

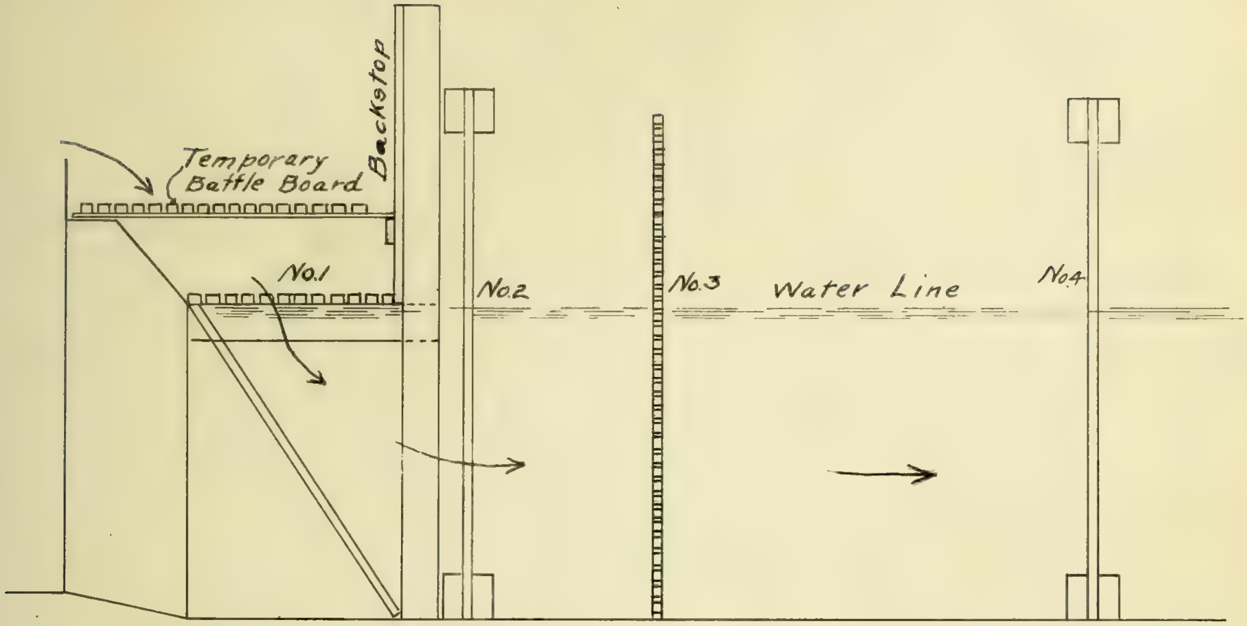
In order to distribute the flow of the water over the entire channel and to quiet the surface of the water, a set of baffle boards are used for each weir, a general idea of which may be obtained from the accompanying plate. The baffle boards are placed as near as possible



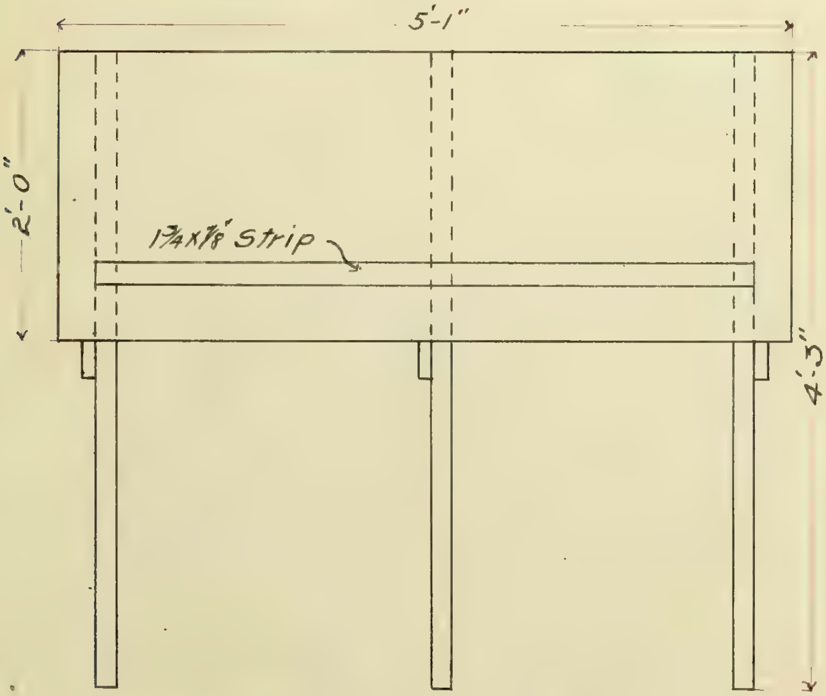
PLAN
OF
BAFFLE BOARDS
ABOVE WEIR NO.1
scale 3/4"=1'



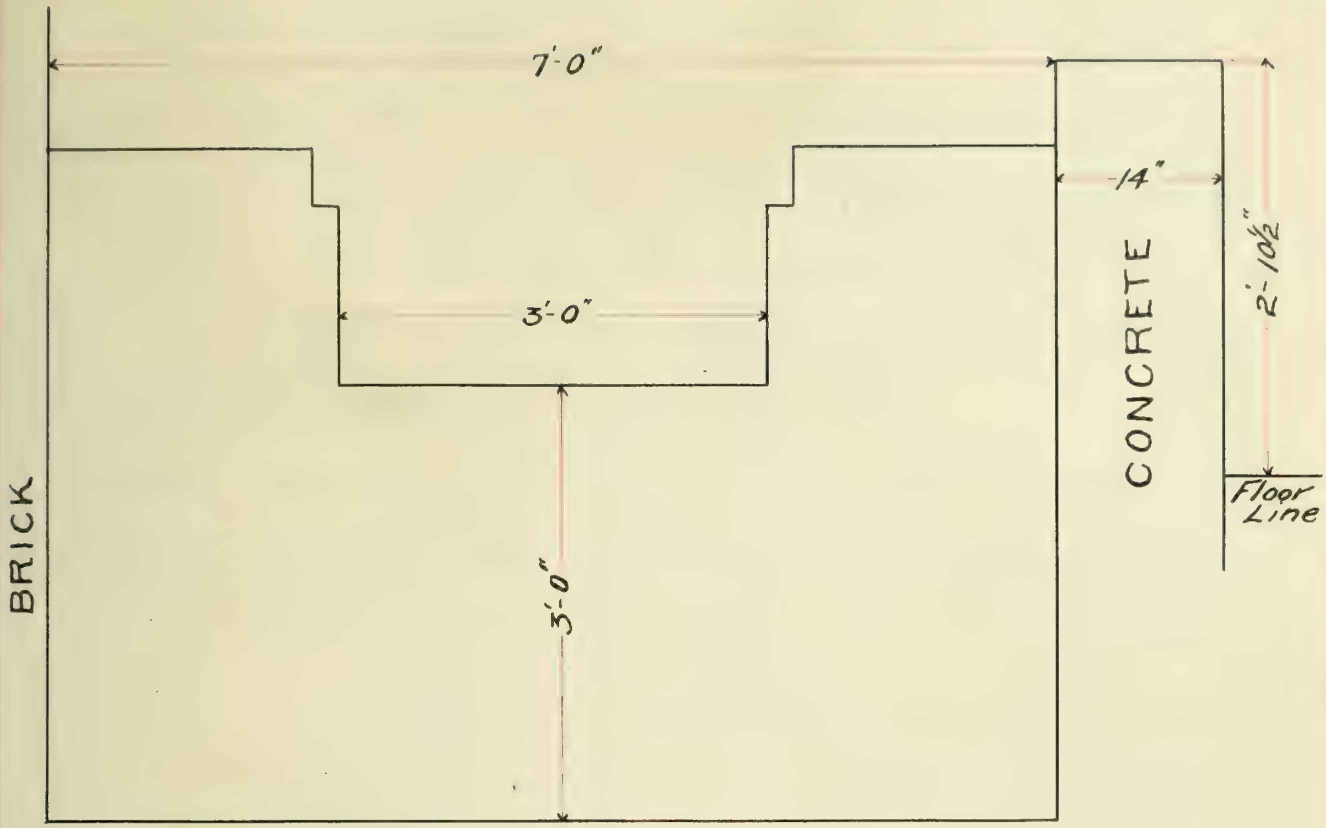
PLAN OF BAFFLE BOARDS
BELOW WEIR NO.1
Scale 3/4"=1'



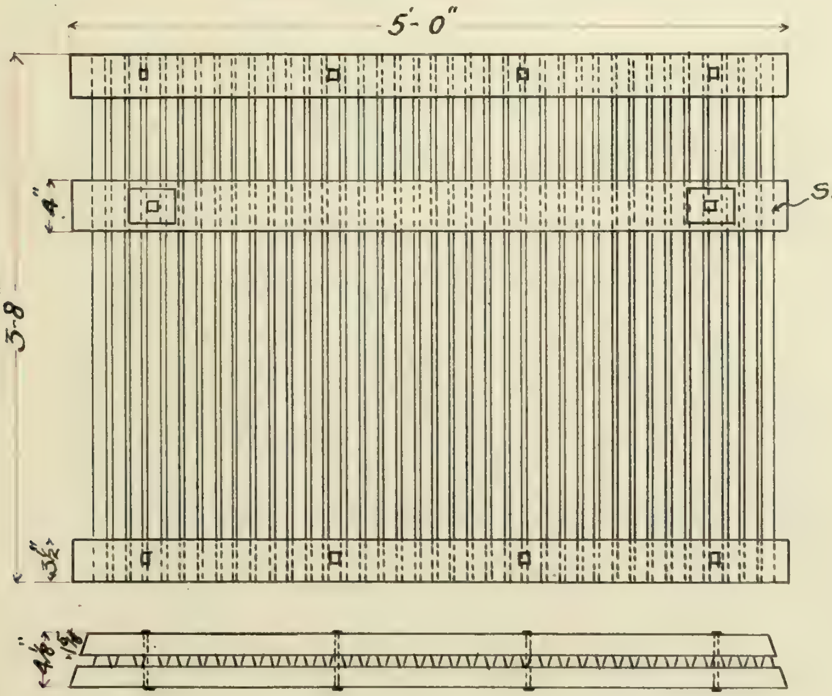
CROSS SECTION OF BAFFLE BOARDS
BELOW WEIR NO. 1
Scale 3/4"=1'

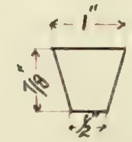


FRONT VIEW OF BACKSTOP
Scale 3/4"=1'



SIDE VIEW OF WEIR NO. 1
Scale ¾" = 1'





Slat
Scale ⅜" = 1"

PLAN AND FRONT VIEW
OF
BAFFLE BOARD NO. 2
BELOW WEIR NO. 1
Scale ¾" = 1'

to the place of water entrance in order to have the surface of water as smooth as possible for the hook gauges, which must necessarily be placed some distance in front of the weir, because of the curve which the surface of water assumes in flowing to the weir. There are 4 baffle boards in the channel of Weir No. 1; in Nos. 1 and 3 the slats are horizontal, while in Nos. 2 and 4 the slats are vertical. In the channel of Weir No. 2, the arrangement of baffle boards is somewhat different from that in the channel of Weir No. 1. No. 1 is a baffle board placed horizontally, upon which the water falls over the contracted weir. At the back of this baffle board, there is a board "backstop" extending across the channel, which causes the water

to fall through baffle board No. 1, instead of running over it as it otherwise would. A temporary horizontal baffle board, supported on one side by the apron of Weir No. 1, and on the opposite side by a strip of wood nailed to the above-mentioned "backstop", is placed above baffle board No. 1 to better distribute the current. The water is prevented from flowing backward and causing eddies as the water flows over the weir by an inclined board extending across the channel, and reaching from the apron to the bed of the channel. The arrangement of this board may be seen on plate showing the cross section of the baffle boards. The slots in baffle boards Nos. 2 and 4 are 1 in. wide on the up-stream side and ½ in. wide on the down-stream side, having a batter of

c

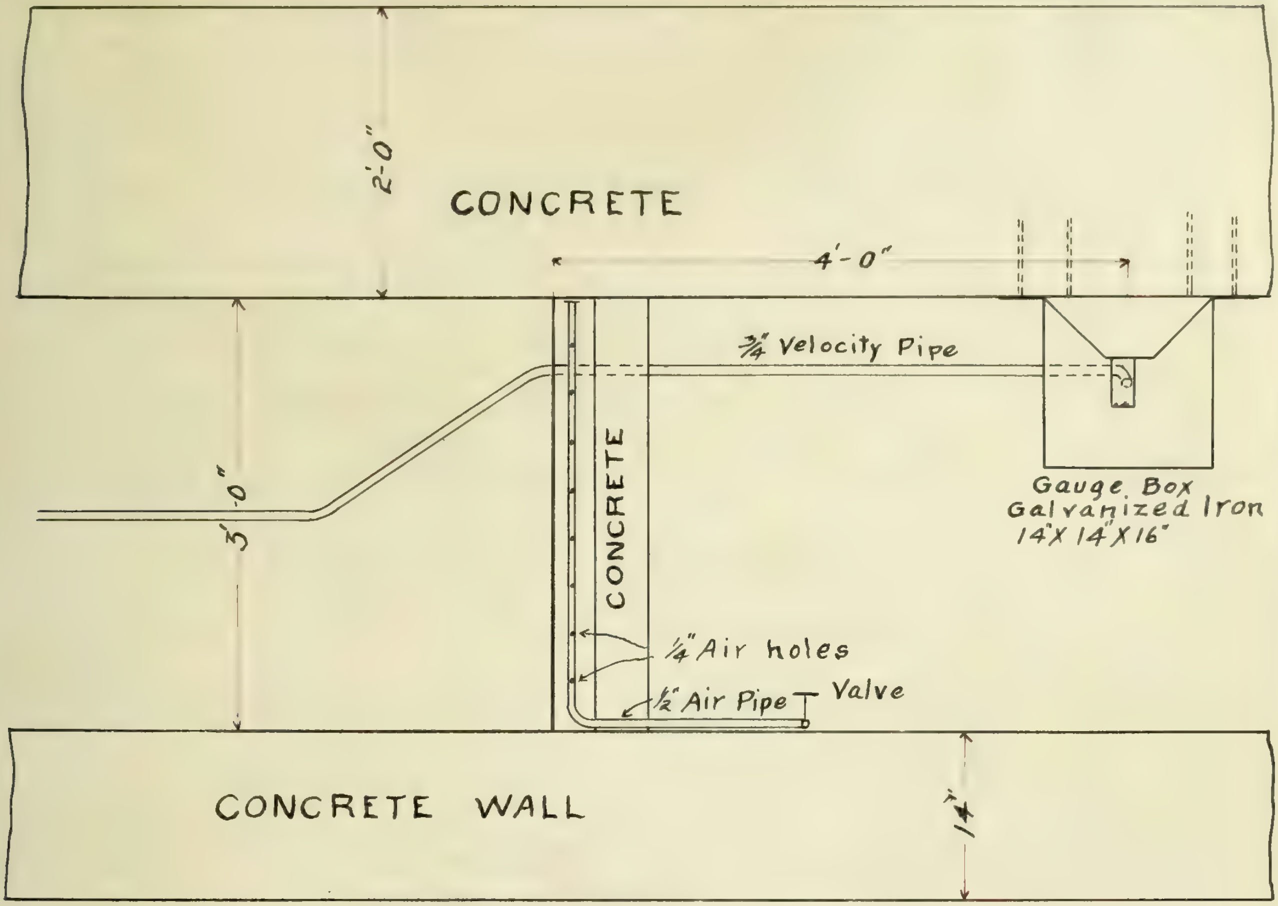
6 in. on each side of the slat.
A section of a slat may be seen
on drawing of baffle board No. 1.
The object of this arrangement is
to break up the current, and
still allow the water to pass
through with low velocity. To
each baffle board No. 2 and No. 4
is fastened a movable "surface
board". These boards are 8 in. by
4 in. and extend across the chan-
nel. Their function is to allay
the surface of the water of all
wave motion. They should be
so adjusted that the lower
edge of the board is just be-
low all wave action in the
surface of the water.

There are three hook gauges
reading to thousandths of a foot,
the location of which may be
seen by referring to plan of
basement. The hook gauge for
the channel of Weir No. 1 is

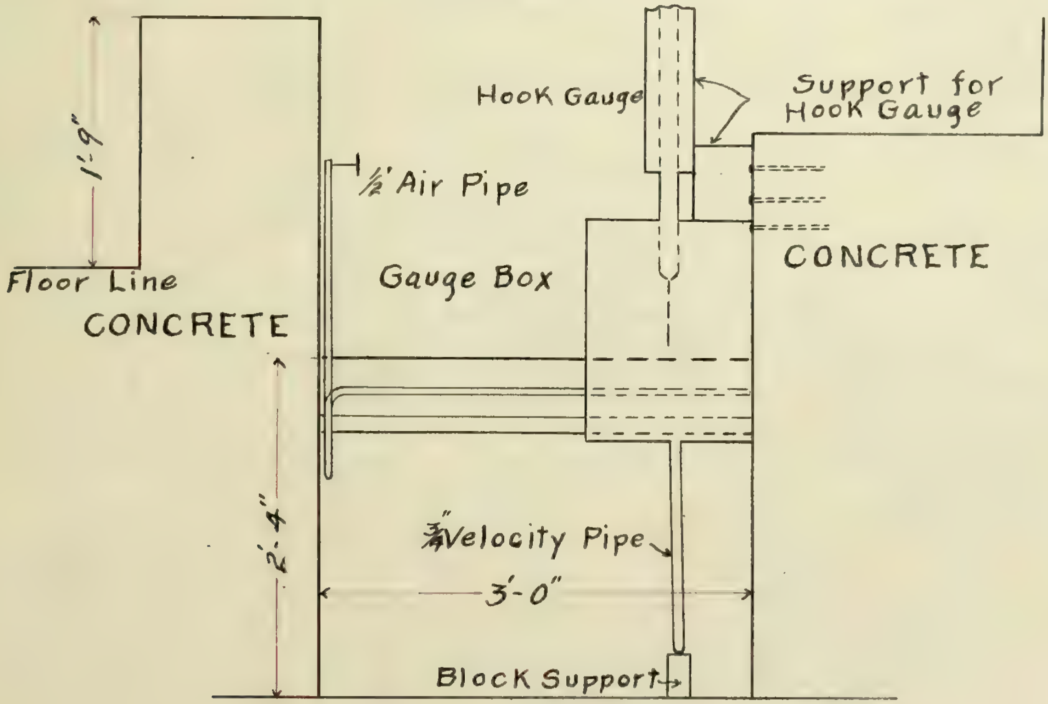
fixed on the outside of the channel wall 7 ft. up from the weir. The water is brought from the weir channel through a ¾ in. pipe into a galvanized iron box 14"x14"x16" bolted to the concrete wall just below the hook gauge. Into this ¾-in. pipe, which extends across the channel, are screwed 7 piezometer tubes ¼ in. interior diameter, 6 in. long, spaced 12 in. apart, with open ends upstream. It is intended then that the reading of the hook gauge in the box outside the weir channel is the sum of the hydrostatic head and the head due to velocity of approach. At a distance 8 ft. 4 in. above Weir No. 2, bolted to the channel wall on the inside, another hook gauge is placed. The reading of this gauge is the hydrostatic head of the water flowing over the weir.

As the coefficients for the suppressed weir are calculated using the hydrostatic head, the readings of this hook gauge will be used.

To obtain the hydrostatic head and velocity head, an arrangement similar to that of Weir No.1 is made for Weir No.2. At a distance 7 ft. above the weir are six piezometer tubes 4 in. interior diameter, 6 in. long and spaced 6 in. apart transversely of the channel. These tubes receive the water to be communicated to the galvanized iron gauge box, fastened to the concrete wall of the channel, 4 ft. below the weir. These piezometer tubes are located at such a height above the bed of the channel that, with a considerable head of water flowing over the weir, they receive the water flowing at the



PLAN OF WEIR NO. 2
Scale 3/4"=1'

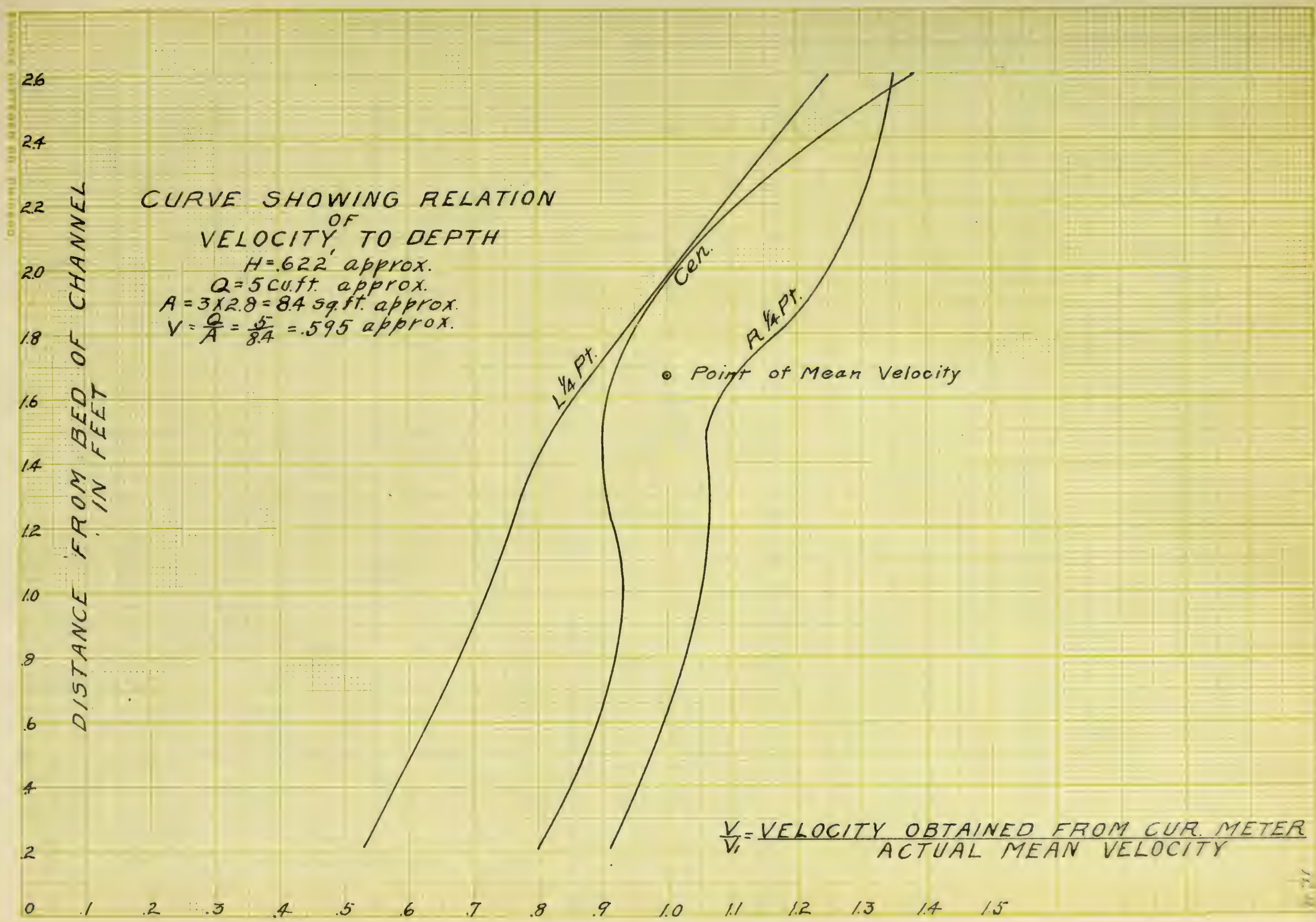


SIDE VIEW OF WEIR NO. 2
Scale 3/4"=1'

mean velocity, and transfer the head due to this velocity to the lower gauge box. In order to determine the locations of these tubes, several experiments with a current meter were taken with different heads of water, at different points transversely of the channel. In a section across the channel, readings of the current meter were taken in three vertical lines at different heights from the bottom of the channel. These three vertical lines divided the channel into four equal parts, so that the current of the water was found at points 9 in. from the sides, and in the middle of the channel. The actual mean velocity of the water was found by the formula $\frac{Q}{A} = V$. Q was found by weir measurement using the coefficients given in Merriman's Hydraulics

The area was found by multiplying the depth of water in the channel by the width of the channel. The ratios of the velocities found at different points by the current meter, and of the mean velocity found from computation using the head of water at time of meter reading were found; and the results were plotted on coördinate paper, having the height above bed of channel as ordinates and the ratios of the two velocities as abscissas. The curves obtained from an experiment with about .622 ft. head on weir are shown on next page. From these curves, the place of mean velocity was shown to be about 20 in. above the bed of channel.

For all heads up to .325 ft. on the weir, the water is obtained from the standpipe. The flow


CURVE SHOWING RELATION OF VELOCITY TO DEPTH
H=.622' approx.
Q=5 cu.ft. approx.
A=3X2.8=8.4 sq.ft. approx.
V=Q/A=5/8.4=.595 approx.
L 1/4 Pt.
Cen.
R 1/4 Pt.
Point of Mean Velocity
V/V1 = VELOCITY OBTAINED FROM CUR. METER / ACTUAL MEAN VELOCITY
DISTANCE FROM BED OF CHANNEL IN FEET
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
.8
.6
.4
.2
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
1.1
1.2
1.3
1.4
1.5

is kept nearly constant by gradually opening the valve of the supply pipe, as the head of water falls in the stand pipe. Since the flow can not be kept constant by this method, several gauge readings are taken during an experiment, and the average head is used in computation. The quantity of water discharged during an experiment is measured in the sump. The rise of water is obtained by means of a float. The float used is a hollow sphere of iron about 8 in. in diameter; to this is connected a ½ in. pipe rod about 10 ft. long with a pointer on the end. This pointer moves along a common leveling rod, reading to hundredths of a foot, placed at the top of the sump. In order that the float may not be affected by circumferential velocity or by the wave

motion of the water in the sump it is encased in a 12-in. galvanized iron pipe about 9 ft. long resting on the bottom of the sump. There is a 3 in. flange on the lower end of this pipe, to which is fastened a baffle board and a gunny sack to check the wave motion of the water as it rises in the sump. While the required head on the weir is being obtained, the water must be pumped into the standpipe as fast as it flows into the sump; this is necessary in order that sufficient space may be had in the sump to measure the water which flows in during the experiment proper. The time is kept by means of a stop watch reading to 5ths of a second. The duration of each experiment is from 17 minutes with the lowest head to 2½ minutes with the

highest head, the time being limited by the water available in the standpipe. In taking an experiment the stop watch is started simultaneously with taking the level of water in the sump. Two observers are necessary in taking the experiments; one person to regulate the valve of the supply pipe, and the other to take time and read the rod and hook gauges.

For heads higher than .343 ft. on the weir, the water is obtained from one of the storage tanks in the University Water Works. The reasons for using this source of supply are: (1) with such large quantities of water flowing over the weirs, the supply of water in the standpipe gives too short a time to an experiment; (2) during the preliminary work of obtaining the desired head on

the weir, the steam pump could not pump the water out of the sump into the standpipe as fast as it comes into the sump from flowing over the weirs. By using the storage tank as a source of supply, the water discharged over the weirs may be measured in the tank itself. To prevent the water from backing up over the weirs, it is wasted into the Boneyard Branch through an 18 in. cast iron pipe connected with the sump. The fall of the water in the tank is measured by a float in a manner similar to that used for measuring the rise of the water in the sump. Upon the top of the storage tank is built a board platform with a circular hole 13 in. in diameter cut into it. The 12 in. galvanized iron pipe passes through this hole, and is suspended by means of the 3 inch

flange at the end. The float with pointer fastened to end of the 1/4 pipe rod is placed in the 2 in galvanized iron pipe, in order to keep the rod in a vertical position. As the water falls in the tank, the pointer moves along a reading rod fastened vertically at the top of the platform. The signal for the beginning and end of an experiment is given to the observer in the water works by means of an electric bell. At this signal the reading of the water level in the tank is taken. The flow of water over the weir is kept at the desired head by regulating the valves in the supply pipes. The reading of the hook gauges is taken at 1/2 minute intervals during the experiment; and the average head is used in computing the coefficients for the weirs.

With these higher heads on the weirs, the head due to velocity of approach is appreciable, and must be taken into account in the calculations. In order to find this head, the mean velocity of the flow is first found by the formula $V = \frac{Q}{A}$. Q is known from actual measurement; and A is found by multiplying the depth of water flowing in the channel by the width of channel. Having the mean velocity, the head due to velocity of approach is obtained by the formula $h = \frac{v^2}{2g}$. Since the velocity of the water is not constant throughout the section of the channel, but greatest at the top where the water is flowing over the weir, the head due to this velocity is taken as $1\frac{1}{3}$ times the head due to the mean velocity. Since

the hydrostatic head and velocity head both affect the discharge over the weir, the effective head H+1.5h is used in determining the coefficients.

In determining the coefficients for these weirs an error may be made in setting the hook gauges level with the crest of the weirs. Much care was taken in finding the zero reading of the gauges, since the head of water on the weir appears in the formula to the 3/2 power. Since the hook gauges read to thousandths of a foot, and since the head on the weirs is a varying head, an error may also be made in finding the head of water flowing over the weirs. An error of .001 ft. in the reading of a head of .20 ft. on the suppressed weir causes an error of .6 of 1% in

the value of the coefficient c; and if an error of .002 ft. in the reading be made, an error of 1.2 % occurs in the value of c.

Another error may occur in finding the quantity of water discharged during an experiment. The water is measured in the sump and is computed as in finding the solid contents of a cylinder. The diameter of the sump varies slightly at different heights and at different points in the circumference; the diameter is therefore not definitely known. However it is taken as averaging 11 feet 11½ inches. If an error of ¼ in. be made in taking the diameter of the sump as 11 ft. 11¾ in., an error of .3 of 1% results in the coefficient c. The graduated rod used in finding the rise of water during an experiment is

read to hundredths of a foot.
The height of the water at the beginning and end of an experiment must be found while water is continually running into the sump. This manner of finding the height is a source of considerable error, since the wave motion in the sump causes the float to move up and down as the water rises. If, with a rise of 3 ft. in the sump, an error of .02 ft. be made in the reading thereof, an error of .7 of 1% results in the coefficient C. It was found out by experiment that water came into the sump from other sources than over the weir, supposedly from the suction pipe caused by the pump losing its priming. Since this amount of water varied on different days and with the

hour after the pump was shut down, experiments were made every day to find out the corrections to be applied to the rod reading. This corrected height is the rise of the water which flows over the weir, and is used in the computations to find the quantity of water discharged. Since the conditions under which the corrections were determined are somewhat different from those occurring in an experiment with water flowing over the weir, an error of .01 ft. rise in the sump may be assumed to occur. If this error be made with 3 ft. rise in the sump, an error of .3 of 1% results in the coefficient & in the cases mentioned a maximum error of .6% may occur in the results. However the results of all the experiments

taken varied but little over 1% from a mean value.

The zero readings of the hook gauges were found to be for — Weir No. 1 Contracted Weir — 1.047 ft., Weir No. 2 Suppressed Weir, Channel Hook Gauge — .720 ft., and for Box Hook Gauge — 1.095 ft.

In the calculations the accessible area of the sump was taken as 111.48 sq. ft. The diameter of the sump was taken as 11 ft. $11\frac{3}{4}$ in.

Area of sump	= 112.70 sq. ft.
Deduct for suction pipe of pump	.44 sq. ft.
Deduct for pipe to waterworks	.78 sq. ft.
Accessible area of sump =	111.48 sq. ft.

Tables 1 to 7 give the data of the experiments and give the resulting coefficients for the suppressed and contracted weirs with different heads of water. Curves are presented in Plate 1 showing these coefficients together with the coefficients given in Merriman's Hydraulics. Tables

9 to 12 give the discharge over the weirs using the coefficients determined from Plate 1. Plates 2 and 3 represent this calculated discharge for heads up to .5 ft. on the suppressed and contracted weirs. The points marked on the diagrams are the discharges given by Merriman's coefficients.

Note:- The writer is indebted to Mr. J. L. Hunton for valuable information obtained from his preliminary work upon this subject.

FLOW OF WATER OVER SUPPRESSED WEIR

TABLE I.

Average Head on Weir Ft.	Rise in Sump Ft.	Corrected Rise in Sump Ft.	Quantity Discharged Cu. Ft.	Time in sec.	Actual Discharge Cu. Ft per sec	$H^{3/2}$	Theo. Discharge Cu. Ft. per sec. $\frac{2}{3}\sqrt{2g}\, b\, H^{3/2}$	C
.0934	2.85	2.805	312.7	1018.0	0.3072	.02854	0.4578	.671
.0928	2.65	2.605	290.4	956.4	0.3036	.02827	0.4535	.669
.0928	2.80	2.755	307.1	1006.2	0.3052	.02827	0.4535	.673
.0946	2.75	2.705	301.6	966.0	0.3122	.02910	0.4668	.669

Mean = .671

TABLE II.

.1250	2.52	2.52	280.9	598.8	0.4691	.04419	0.7088	.662
.1250	2.45	2.45	274.1	589.0	0.4654	.04419	0.7088	.657
.1270	2.62	2.62	292.1	619.0	0.4719	.04526	0.7260	.650
.1270	2.50	2.47	275.4	571.4	0.4820	.04526	0.7260	.664
.1285	2.68	2.635	293.7	604.8	0.4856	.04606	0.7388	.657
.1253	2.50	2.455	273.7	592.4	0.4620	.04435	0.7114	.649
.1250	2.40	2.355	262.5	564.8	0.4648	.04419	0.7088	.656

Mean = .656

FLOW OF WATER OVER SUPPRESSED WEIR

TABLE III.

Average Head on Weir Ft.	Rise in Sump Ft.	Corrected Rise in Sump Ft.	Quantity Discharged Cu. Ft.	Time in sec.	Actual Discharge Cu. Ft. per sec.	$H^{3/2}$	Theo. Discharge Cu. Ft. per sec. $\frac{2}{3}\sqrt{2g}\, b\, H^{3/2}$	c
.1460	2.65	2.63	293.2	504.8	0.5808	.05578	0.8947	.649
.1490	2.45	2.43	270.9	448.6	0.6039	.05751	0.9225	.655
.1500	2.70	2.68	298.8	493.2	0.6058	.05810	0.9319	.650
.1504	2.65	2.63	293.2	477.4	0.6142	.05833	0.9356	.656
.1510	2.50	2.48	276.5	453.2	0.6101	.05868	0.9412	.648

Mean = .652

TABLE IV.

.2230	2.50	2.485	277.0	256.4	1.080	0.1053	1.689	.639
.2205	3.00	2.985	332.8	313.8	1.061	0.1035	1.660	.639
.2200	3.20	3.185	355.1	335.4	1.059	0.1032	1.655	.640
.2176	3.05	3.035	338.3	323.2	1.047	0.1015	1.628	.643
.2176	3.10	3.085	343.9	326.0	1055	0.1015	1.628	.648

Mean = .642

FLOW OF WATER OVER SUPPRESSED WEIR

TABLE V.

Average Head on Weir Ft.	Rise in Sump Ft.	Corrected Rise in Sump Ft.	Quantity Discharged Cu. Ft.	Time in sec.	Actual Discharge Cu. Ft. per sec.	$H^{3/2}$	Theo. Discharge Cu. Ft. per sec. $\frac{2}{3}\sqrt{2g}\, b\, H^{3/2}$	c
.2896	3.09	3.06	341.1	211.6	1.612	0.1558	2.499	.645
.2900	3.10	3.07	342.2	210.8	1.623	0.1562	2.505	.648
.2887	3.30	3.27	364.5	225.8	1.614	0.1551	2.488	.649
.2913	3.00	2.97	331.1	204.4	1.620	0.1572	2.521	.643
.2890	3.20	3.17	353.4	218.6	1.617	0.1554	2.493	.649

Mean = .647

TABLE VI.

.3190	2.55	2.54	283.2	152.4	1.858	0.1802	2.890	.643
.3236	2.50	2.49	277.6	145.8	1.904	0.1841	2.943	.647
.3210	2.50	2.49	277.6	148.4	1.871	0.1819	2.918	.641
.3240	2.75	2.74	305.4	160.0	1.909	0.1844	2.958	.645
.3220	2.50	2.49	277.6	146.6	1.894	0.1827	2.931	.647

Mean = .645

FLOW OF WATER OVER SUPPRESSED WEIR

TABLE VII.

Average Head on Weir Ft.	Fall in Tank Ft.	Quantity Discharged Cu. Ft.	Time in sec.	Actual Discharge Cu. Ft. per sec.	h	$(H+1\frac{1}{3}h)^{3/2}$	Theo. Discharge Cu. Ft. per sec. $\frac{2}{3}\sqrt{2g}\,b\,(H+1\frac{1}{3}h)^{3/2}$	c
.4844	3.39	1065.0	300.2	3.548	.003	0.3413	5.474	.648
.4903	4.11	1291.2	360.0	3.587	.003	0.3475	5.574	.644
.4867	4.02	1262.9	360.2	3.506	.003	0.3437	5.513	.636

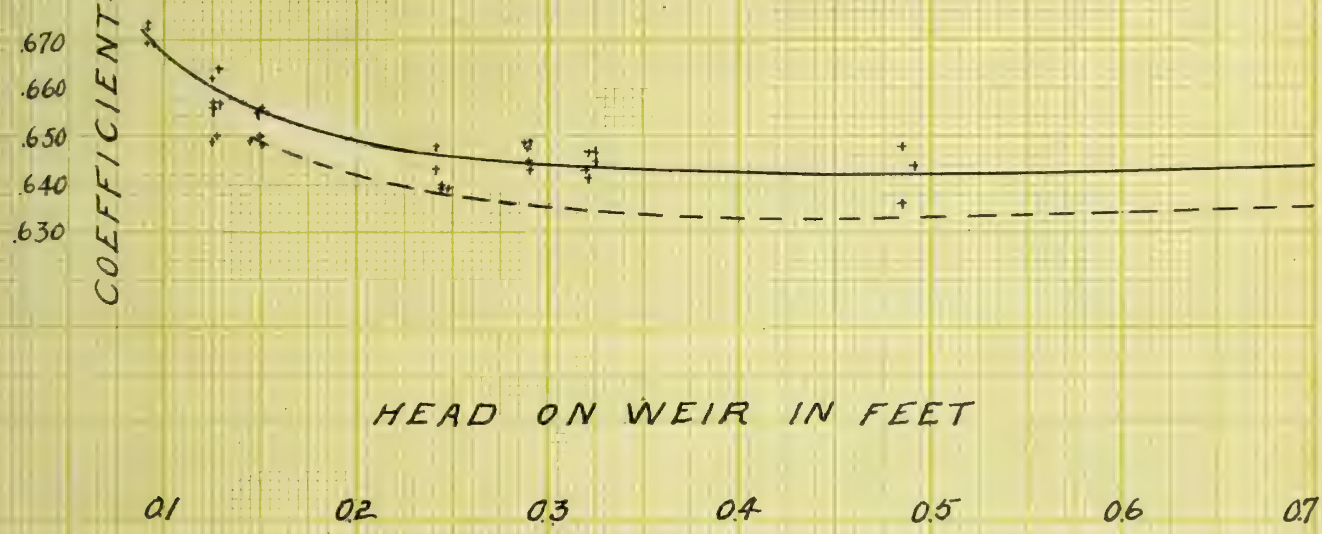
Mean = .643

TABLE VIII.
CALIBRATION OF CONTRACTED WEIR

Head on Suppressed Weir in Ft.	$H^{3/2}$	c for Suppressed Weir	Head on Contracted Weir in Ft.	$H^{3/2}$	c for Contracted Weir
0.092	0.02790	.670	0.094	0.02882	.648
0.130	0.04687	.659	0.132	0.04796	.644
0.144	0.05464	.656	0.146	0.05578	.643
0.168	0.06886	.652	0.170	0.07009	.641
0.216	0.10040	.648	0.219	0.1024	.635
0.296	0.1610	.644	0.302	0.1660	.625
0.323	0.1836	.643	0.331	0.1904	.620
0.484	$(H+1\frac{1}{3}h)^{3/2}$ 0.3409	.642	0.505	0.3589	.610

CURVES SHOWING RELATION OF COEFFICIENTS TO HEADS ON SUPPRESSED WEIR

The dotted curve is for Merriman's coefficients. The points indicate values for coefficients found from experiments.



CURVES SHOWING RELATION OF COEFFICIENTS TO HEADS ON CONTRACTED WEIR

The dotted curve is for Merriman's coefficients. The full line gives values for coefficients found from experiments.

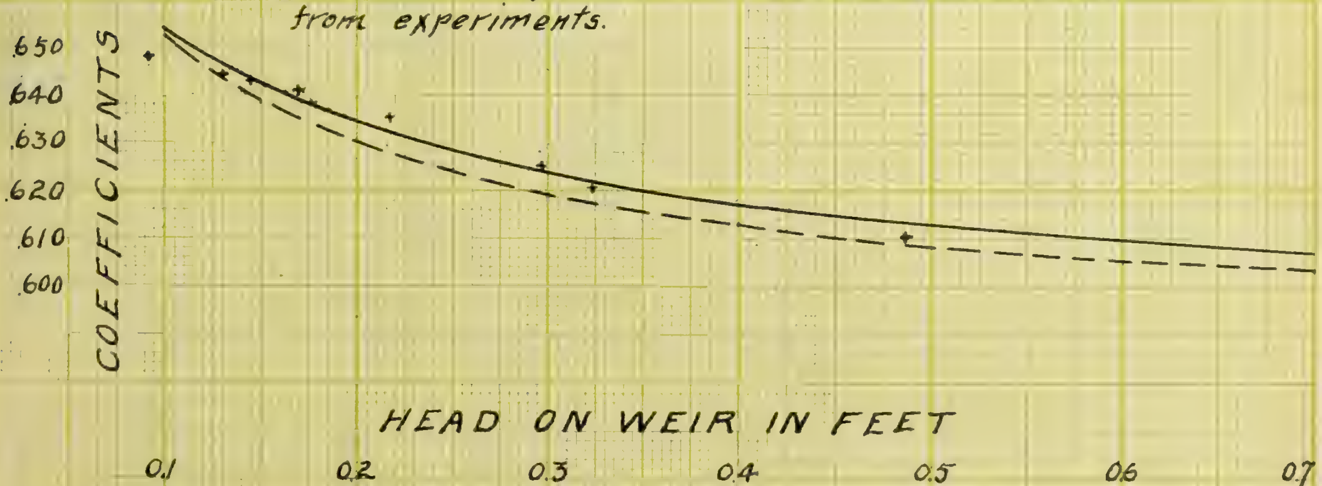


Plate 1

TABLE IX.

DISCHARGE FROM THE 3 FT. SUPPRESSED WEIR WITH DIFFERENT HEADS USING THE COEFFICIENTS FOUND FROM EXPERIMENTS

Head on Weir	c	$\frac{2}{3}\sqrt{2g}\,b$	$H^{3/2}$	Cu. Ft. per sec.
.093	.670	16.04	.02836	.3048
.125	.660	16.04	.04419	.4678
.150	.655	16.04	.05810	.6104
.220	.648	16.04	.1032	1.073
.290	.644	16.04	.1562	1.614
.322	.643	16.04	.1827	1.884
.490	.642	16.04	.3430	3.546

TABLE X.

DISCHARGE FROM A 3 FT. SUPPRESSED WEIR WITH DIFFERENT HEADS USING THE COEFFICIENTS GIVEN IN MERRIMAN'S HYDRAULICS

Head on Weir	c	$\frac{2}{3}\sqrt{2g}\,b$	$H^{3/2}$	Cu. Ft. per sec.
0.15	.649	16.04	.0581	.604
0.2	.642	16.04	.0894	.920
0.25	.638	16.04	.1250	1.279
0.3	.636	16.04	.164	1.676
0.4	.633	16.04	.253	2.568
0.5	.633	16.04	.3535	3.589
0.6	.634	16.04	.465	4.728
0.7	.635	16.04	.586	5.969
0.8	.637	16.04	.7155	7.310
0.9	.639	16.04	.854	8.750
1.0	.641	16.04	1.0	10.281

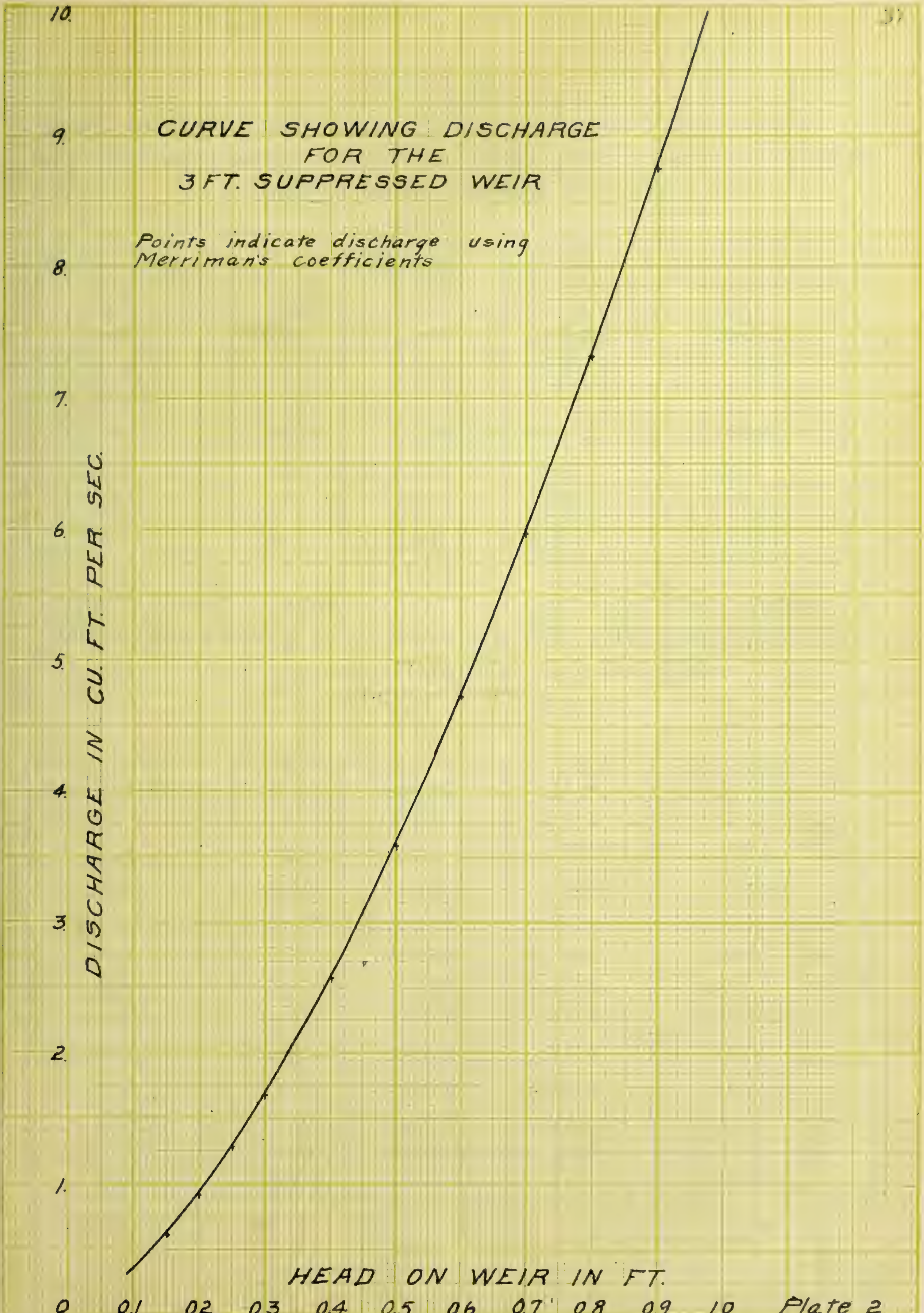

CURVE SHOWING DISCHARGE
FOR THE
3 FT. SUPPRESSED WEIR
Points indicate discharge using
Merriman's coefficients
DISCHARGE IN CU. FT. PER SEC.
HEAD ON WEIR IN FT.
0
1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0

Plate 2

TABLE XI.

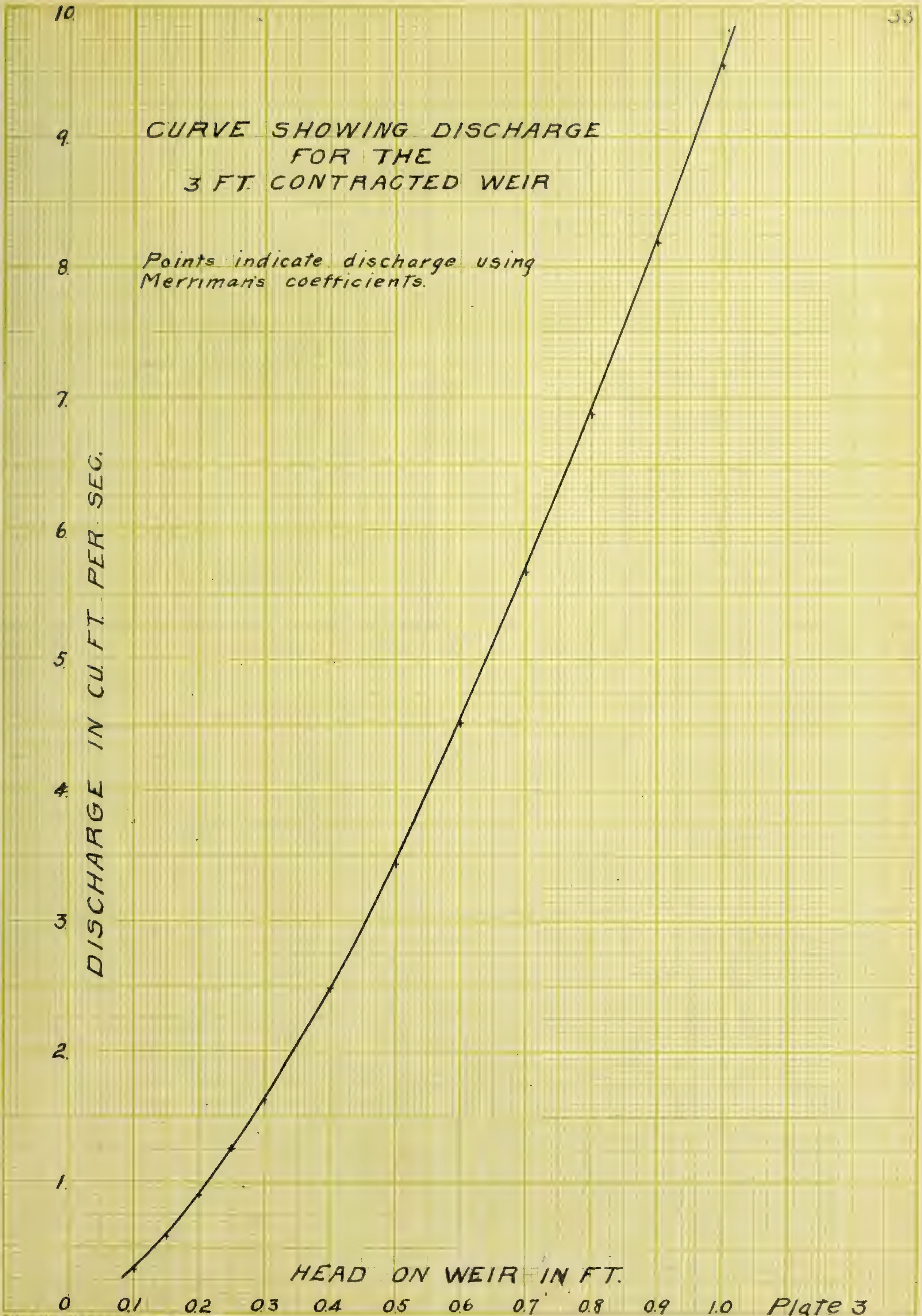
DISCHARGE FROM THE 3 FT. CONTRACTED WEIR WITH DIFFERENT HEADS USING THE COEFFICIENTS FOUND FROM EXPERIMENTS

Head on Weir	c	$\frac{2}{3}\sqrt{2g}\,b$	$H^{3/2}$	Cu. Ft. per sec.
.094	.652	16.04	.02882	.3016
.132	.646	16.04	.04796	.4970
.146	.643	16.04	.05578	.5753
.170	.638	16.04	.07009	.7172
.219	.632	16.04	.1024	1.038
.302	.624	16.04	.1660	1.661
.331	.621	16.04	.1904	1.897
.505	.612	16.04	.3589	3.523

TABLE XII.

DISCHARGE FROM A 3 FT. CONTRACTED WEIR WITH DIFFERENT HEADS USING THE COEFFICIENTS GIVEN IN MERRIMAN'S HYDRAULICS

Head on Weir	c	$\frac{2}{3}\sqrt{2g}\,b$	$H^{3/2}$	Cu. Ft. per sec.
0.1	.652	16.04	.0316	.3305
0.15	.638	16.04	.0581	.5945
0.2	.630	16.04	0.894	.9034
0.25	.624	16.04	.125	1.251
0.3	.619	16.04	.164	1.628
0.4	.613	16.04	.253	2.487
0.5	.608	16.04	3535	3.447
0.6	.605	16.04	.465	4.512
0.7	.603	16.04	.586	5.668
0.8	.600	16.04	.7155	6.886
0.9	.598	16.04	.854	8.192
1.0	.595	16.04	1.0	9.544


CURVE SHOWING DISCHARGE
FOR THE
3 FT. CONTRACTED WEIR
Points indicate discharge using
Merriman's coefficients.
DISCHARGE IN CU. FT. PER SEC.
HEAD ON WEIR IN FT.
0
1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
Plate 3